AMENDMENT TO THE CLAIMS

1. (previously presented): A spin valve sensor for producing a giant magnetoresistive (GMR) effect on a sense current, which travels in a longitudinal direction, in response to applied magnetic fields, the sensor comprising:

a first ferromagnetic free layer having a magnetization (M_1) in a first direction that is aligned in the longitudinal direction when in a quiescent state;

a second ferromagnetic free layer having a magnetization (M_2) in a second direction that is anti-parallel to the first direction when in a quiescent state;

a spacer layer between the first and second ferromagnetic free layers; and

a permanent magnet positioned above the first and second ferromagnetic free layers opposite an air bearing surface (ABS) and producing a bias magnetic field that biases both M_1 and M_2 in a third direction that is transverse to the first and second directions thereby establishing quiescent bias states for M_1 and M_2;

wherein M_1 and M_2 rotate about their quiescent bias states in response to an applied magnetic field.

2. (previously presented) The spin valve sensor of claim 1, including an insulating layer between the permanent magnet and the first and second ferromagnetic free layers.

3. Cancelled.

4. (original): The spin valve sensor of claim 1, wherein the third direction is selected from a group consisting of downward and upward.

5. (previously presented): The spin valve sensor of claim 1, including first and second contacts respectively positioned in contact with first and second ends of the first and second ferromagnetic free layers and the spacer layer, wherein the sense current is configured to flow between the first and second contacts in the longitudinal direction.

6. (previously presented): The spin valve sensor of claim 5, including:

a bottom shield proximate the first ferromagnetic free layer and the contacts; and

a top shield proximate the second ferromagnetic free layer and the contacts.

7. (previously presented): The spin valve sensor of claim 1, wherein M_1 and M_2 are oriented in a direction that is about 45° relative to the sense current when in their quiescent bias states.

8. (original): A data storage system including a spin valve sensor in accordance with claim 1.

9. (previously presented): A method of sensing an applied magnetic field, comprising steps of:

(a) providing a first ferromagnetic free layer having a magnetization (M_1) in a first direction that is aligned with a sense current (I) in a longitudinal direction, when in a quiescent state;

(b) providing a second ferromagnetic free layer having a magnetization (M_2) in a second direction that is anti-parallel to the first direction, when in a quiescent state;

Cont'd

(c) applying a bias magnetic field to the first and second ferromagnetic free layers with a biasing component thereby angling M_1 and M_2 toward a third direction that is transverse to the first and second directions and establishing a quiescent bias state, wherein the biasing component is either ~~a permanent magnet positioned above the first and second ferromagnetic free layers opposite an air bearing surface~~, or a <u>first</u> anti-ferromagnetic layer exchange coupled to the <u>first</u> ferromagnetic free layer and a second anti-ferromagnetic layer exchange coupled to the second ferromagnetic free layer; and

(d) allowing M_1 and M_2 to rotate about their quiescent bias states in response to an applied magnetic field.

10. Cancelled.

11. (previously presented): A spin valve sensor for producing a giant magnetoresistive (GMR) effect on a sense current, which travels in a longitudinal direction, in response to applied magnetic fields, the sensor comprising:

a first ferromagnetic free layer having a magnetization (M_1) in a first direction that is aligned in the longitudinal direction when in a quiescent state;

a second ferromagnetic free layer having a magnetization (M_2) in a second direction that is anti-parallel to the first direction when in a quiescent state;

a spacer layer between the first and second ferromagnetic free layers;

a biasing component including a first anti-ferromagnetic layer exchange coupled to the first ferromagnetic free layer and a second anti-ferromagnetic layer exchange coupled to the second ferromagnetic free layer, the

first and second anti-ferromagnetic layers each producing a bias magnetization field that respectively biases M_1 and M_2 in a third direction that is transverse to the first and second directions thereby establishing quiescent bias states for M_1 and M_2; and

wherein M_1 and M_2 rotate about their quiescent bias states in response to an applied magnetic field thereby producing a GMR effect in the sensor as a function of the rotation of M_1 and M_2.

12. (previously presented): The spin valve sensor of claim 11, wherein the third direction is selected from a group consisting of downward and upward.

13. (previously presented): The spin valve sensor of claim 11, including first and second contacts respectively positioned in contact with first and second ends of the first and second ferromagnetic free layers and the spacer layer, wherein the sense current flows between the first and second contacts in the longitudinal direction.

14. (previously presented): The spin valve sensor of claim 13, including:

a bottom shield proximate the first ferromagnetic free layer and the contacts; and

a top shield proximate the second ferromagnetic free layer and the contacts.

15. (previously presented): The spin valve sensor of claim 11, wherein M_1 and M_2 are oriented in a direction that is about 45° relative to the sense current when in their quiescent bias states.

Cont

16. (previously presented): A data storage system including a spin valve sensor in accordance with claim 11.

17. (previously presented): A method of manufacturing a spin valve sensor for producing a giant magnetoresistive (GMR) effect in response to applied magnetic fields, the method comprising steps of:

(a) forming a first ferromagnetic (FM) free layer having a magnetization (M_1) in a first direction when in a quiescent state;

(b) forming a second FM free layer having a magnetization (M_2) in a second direction that is anti-parallel to the first direction when in a quiescent state;

(c) forming a spacer layer between the first and second FM free layers; and

(d) forming first and second anti-ferromagnetic (AFM) layers on the first and second FM free layers, respectively; the first and second AFM layers each producing a bias magnetization field that respectively biases M_1 and M_2 in a third direction that is transverse to the first and second directions.

18. (previously presented): The method of claim 17, wherein:

the first and second AFM layers have substantially equivalent anneal temperatures; and

the forming step (d) includes setting the bias magnetization fields of the first and second AFM layers simultaneously by cooling the first and second AFM layers through the anneal temperatures while applying a magnetic field in the third direction.

19. (new): A sensor comprising:

Cont

a sensor stack including first and second anti-parallel magnetizations that are aligned in a longitudinal direction of the sensor stack when in a quiescent state; and

a biasing component configured to produce a bias magnetization field that biases both the first and second magnetizations in a third direction that is transverse to the longitudinal direction, wherein the biasing component does not consist of a hard magnetic layer that is aligned in the longitudinal direction and separated from the sensor stack by a non-magnetic layer.

20. (new): The sensor of claim 19, wherein the biasing component includes a permanent magnet positioned above the sensor stack opposite an air-bearing surface.

21. (new): The sensor of claim 19, wherein the biasing component includes a first anti-ferromagnetic layer exchange coupled to a first ferromagnetic free layer of the sensor stack having the first magnetization.

22. (new): The sensor of claim 21 including a second anti-ferromagnetic layer exchange coupled to a second ferromagnetic free layer of the sensor stack having the second magnetization.

23. (new): The sensor of claim 19, wherein the third direction is selected from a group consisting of downward and upward.

24. (new): The sensor of claim 19, wherein the sensor stack includes a:

a first ferromagnetic free layer having the first magnetization;

B1 Cont.

a second ferromagnetic free layer having the second magnetization; and

a spacer layer between the first and second ferromagnetic free layers.